FINAL SURVEY REPORT:

ERGONOMICS INTERVENTIONS

FOR SHIP REPAIR PROCESSES

at

CONTINENTAL MARITIME OF SAN DIEGO, INC. SHIPYARD, San Diego, California

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Public Health Service
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National Institute for Occupational Safety and Health
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PLANT SURVEYED:	Continental Maritime of San Diego, Inc. shipyard, 1995 Bay Front Street, San Diego, California 92113-2122
SIC CODE:	3731
SURVEY DATE:	June 7-8, 2000
SURVEY CONDUCTED BY:	Stephen D. Hudock, NIOSH Steven J. Wurzelbacher, then with NIOSH Karl V. Siegfried, MEMIC
EMPLOYER REPRESENTATIVES CONTACTED:	as of 6/2000: Lee Wilson, Executive Vice President David Harris, Safety Director
EMPLOYEE REPRESENTATIVES CONTACTED:	Not Applicable

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Mention of company names and/or products does not constitute endorsement by the Centers for Disease Control and Prevention (CDC).

ABSTRACT

A pre-intervention quantitative risk factor analysis was performed at various shops and locations within Continental Maritime of San Diego, Inc. shipyard in San Diego, California, as a method to identify and quantify ergonomic risk factors that workers may be exposed to in the course of their normal work duties. Based on ergonomic task analyses, four ergonomic interventions were suggested for implementation at Continental Maritime: 1) upright scaling, chipping, and needle gun tools for the deck scraping process, 2) wheeled, adjustable work stools and knee supports for the deck scraping process and for other workers performing prolonged kneeling or squatting tasks, 3) portable workbenches for the duct installation process, and 4) worker awareness training for welders/ grinders working overhead or in confined spaces (such as onboard deck fitting and pipe welding processes). Of these interventions, it was anticipated that the upright scaling, chipping, and needle gun tools and portable workbenches may have significant impact on reducing musculoskeletal injuries. This report chronicles the associated actions based on these suggestions.

I. INTRODUCTION

IA. BACKGROUND FOR CONTROL TECHNOLOGY STUDIES

The National Institute for Occupational Safety and Health (NIOSH) is the primary Federal agency in occupational safety and health research. Located in the Department of Health and Human Services, it was established by the Occupational Safety and Health Act of 1970. Since 1976, NIOSH has conducted a number of assessments of health hazard control technology on the basis of industry, common industrial process, or specific control techniques. These studies involve a number of steps or phases. Initially, a series of walk-through surveys are conducted to select plants or processes with effective and potentially transferable control technology concepts or techniques. Next, in-depth surveys are conducted to determine both the control parameters and the effectiveness of these controls. The reports from these in-depth surveys are then used as a basis for preparing technical reports and journal articles on effective hazard control measures. Ultimately, the information from these research activities will build a database of publicly available information on hazard control techniques for use by health professionals who are responsible for preventing occupational illness and injury.

IB. BACKGROUND FOR THIS STUDY

The background for this study may be found in two previous reports, "Preliminary Survey Reports: Pre-Intervention Quantitative Risk Factor Analysis for Ship Repair Processes at Continental Maritime of San Diego, Inc. Shipyard," Report No. EPHB 229-16a by Hudock and Wurzelbacher, 2001a and "Interim Survey Report: Recommendations for Ship Repair Processes at Continental Maritime of San Diego, Inc. Shipyard," Report No. EPHB 229-16b by Hudock and Wurzelbacher, 2001b. Both these reports are available at www.cdc.gov/niosh/ergship/reports.html

IC. BACKGROUND FOR THIS SURVEY

The Continental Maritime facility was selected for a number of reasons. It was decided that the project should look at a variety of yards based on product, processes and location. Continental Maritime is registered as a Master Ship Repair (MSR) contractor and is one of the principal maintenance providers for the U.S. Navy. Continental Maritime is considered to be a small- to medium-size yard based on the number of employees and the capacity of the shipyard's docking space.

II. PLANT AND PROCESS DESCRIPTION

IIA. INTRODUCTION

Plant Description: The Continental Maritime shipyard is located on San Diego Bay in southern San Diego, California. The shipyard consists of 14 acres of land and 18 acres of water. Production, administration, and warehouse facilities exceed 300,000 square feet under roof in addition to outside steel fabrication and material storage areas. Continental Maritime operates six piers up to 700 feet in length with a berthing draft of about 35 feet.

Corporate Ties: At the time of the study, Continental Maritime of San Diego, Inc. was a subsidiary of Newport News Shipbuilding Company, providing a West Coast facility for them. Since that time, Newport News Shipbuilding and, consequently Continental Maritime, have been bought by Northrup Grumman, which also recently purchased Litton Ship Systems, including the Ingalls and Avondale shipyards.

Products: Since 1981, Continental Maritime has completed thousands of ship repair contracts for the U.S. Navy including: Regular Overhaul (ROH), New Threat Upgrade (NTU), Selected Restricted Availability (SRA) and Drydock Selected Restricted Availability (DSRA). Repairs and alterations have been completed on combatant systems, hull, mechanical, and electrical systems and habitability concerns. Most of these contracts allow only a very limited timeframe in which the work must be completed and the vessel returned to active duty.

Age of Plant: Approximate age of shipyard facilities is 25 years.

Number of Employees, etc: As of the date of the survey, based on the number of employee hours, Continental Maritime employed the equivalent of about 215 full-time production workers. However, due to the sporadic nature of repair work, the actual number of employees, including part-time and full-time, is closer to 400.

IIB. SELECTED PROCESS DESCRIPTIONS

Four specific processes were identified for further analysis. These processes were: onboard deck scraping, onboard duct installation, onboard deck fitting, and onboard pipe welding.

IIB1. Onboard Deck Scraping Process

When a vessel is in a yard for scheduled maintenance, often the exterior deck's surface must be replaced with a new coating of high-friction anti-slip material. First the old coating must be removed. This is accomplished by using large machines, similar in size and function to commercial floor sanders. However, there are usually numerous fixtures and encumbrances on the deck surface, such as ladders and machinery mounting brackets. Around these fixtures and

in the area between the deck and the bulkheads, the old coating must be removed by using a variety of pneumatic tools including deck scalers, needle guns and scrapers. Since this work is done at deck level, workers must squat, sit, kneel, crawl or lie down in order to reach all the areas that must be stripped of the old coating. Stresses to the lower extremities, neck and back can be quite high depending on the worker posture, whether the posture is constrained, and the length of time the worker must assume that posture. Exposure to the vibration created from using pneumatic vibrating hand tools may contribute to the development of hand-arm vibration syndrome or carpal tunnel syndrome.

IIB2. Duct Installation Process

When a vessel is in the yard for scheduled maintenance, often work is done to the ventilation or exhaust systems onboard. Ductwork can be removed, replaced, or newly installed depending on the proposed work. Working with ductwork is most easily performed on the deck rather than overhead. Duct installation or removal usually requires overhead work to place or remove the duct from its position. Static postures and overhead work may cause strain to the workers' shoulders and neck. Once a piece of duct is on the deck, the worker usually bends over to perform some part of the work process. The back flexion may result in some strain to the worker. The use of powered hand tools, such as grinders or reciprocating saws, exposes the worker to some amount of hand-arm, or segmental, vibration.

IIB3. Onboard Deck Fitting Process

Often during scheduled maintenance activities, portions of the deck of a ship must be removed and refitted to allow access to the areas below for equipment that is being removed or added in the space below. This work requires workers to cut out the deck plate and then weld it back in place when the access hole is no longer required. This work may require workers to work overhead from below the plate to weld or grind off the weld splatter. The overhead work may strain the neck and shoulders of the worker. Welding also requires static and prolonged postures in occasionally awkward postures to complete the necessary weld. Exposure to welding fumes is another consideration.

IIB4. Onboard Pipe Welding Process

During scheduled maintenance activities, piping for the movement of liquids and steam, may have to be repaired or replaced. Often the piping is located against a bulkhead or the hull of the ship limiting access to the piping. Welders will often use stick welding equipment to complete the weld. Stick welding requires static and often awkward postures of the arms of the worker resulting in strain. The neck or back of the worker may be flexed to accommodate viewing the work task. The worker may have to kneel, squat or lay down in order to complete the task. Therefore, the lower extremities may be strained as well as the upper extremities. The possibility of working in confined spaces resulting in awkward postures is relatively high.

III. CONTROL TECHNOLOGY

The following section presents various ergonomic interventions that were suggested for implementation at Continental Maritime. These suggestions are based on the risk factor analysis that was performed at the shipyard in June of 2000 and detailed in the Preliminary NIOSH report (Report No. EPHB 229-16a) by Hudock and Wurzelbacher, 2001a available at http://www.cdc.gov/niosh/ergship/reports.html
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IIIA. Possible Interventions for the Onboard Deck Scraping Process

Although large scaling machines are difficult to use around various encumbrances on the deck surface, there are commercially available long-handled pneumatic tools including deck scalers, needle guns and scrapers. These may reduce the need for the worker to squat, sit, kneel, crawl or lie down in order to reach all the areas that must be stripped of the old coating and may reduce the exposure to vibration. Suggested approximate long-handled tool characteristics were provided in the Interim Report (Report No. EPHB 229-16b) by Hudock and Wurzelbacher, 2001b, available at http://www.cdc.gov/niosh/ergship/reports.html.

Another option for the deck scrapers is the use of commercially available seats designed specifically for kneeling and squatting. These seats may at least improve the postures associated with the use of hand-held scraping tools by enabling the worker to sit to lessen the stress on the knees while still enabling the worker to perform the assigned task at or near floor level without additional strain on the lower back. Supports are also commercially available that attach to the back of the calf to prevent hyperflexion of the knees during squatting postures, such as the Industrial Knee Saver™ available from AliMed, Inc. at www.alimed.com.

IIIB. Possible Interventions for the Duct Installation Process

A commercially available portable workbench, such as the Black and Decker Workmate®, may be used to position the piece of duct at a height sufficient to reduce back flexion and the need to kneel while the worker performs a variety of operations on the duct. Many of these benches come equipped with vises or strap-downs that can be used to secure the duct during work and eliminate the need for a second worker. The reaching associated with overhead work can be minimized by using small step ladders where feasible to raise the worker to the height of the duct, allowing the worker to keep their arms below shoulder height.

IIIC. Possible Interventions for the Onboard Deck Fitting Process and Onboard Pipe Welding Processes

Although welding/grinding in confined spaces and overhead are difficult processes to address with engineering controls, workers may benefit from ergonomic training. A training program, which offers tips on reducing the effects of static and constrained postures, has been developed

by NIOSH and participating shipyards. Management is also encouraged to provide administrative controls in terms of worker rotation and scheduling to reduce the time individual workers are assigned to such tasks. The use of teams (which alternate between set-up work and welding) is one such method observed in a number of shipyards.

IV. IMPLEMENTED INTERVENTIONS

At this time it is not known whether any of the suggested interventions have been implemented at Continental Maritime. There had been no request from the company for available funds to assist in the procurement of suggested items. Upon further follow-up, it was determined that the project contact from the Safety Department within Continental Maritime is no longer with the company in that capacity. Recent communication with the current Health and Safety Director for the shipyard has been promising. Further opportunities to implement the suggested interventions appear likely.

V. CONCLUSIONS

Four distinct construction processes were examined at Continental Maritime to quantify the musculoskeletal risk factors associated with these processes. The processes included: onboard deck scraping, onboard duct installation, onboard deck fitting, and onboard pipe welding. Based on ergonomic task analyses, four ergonomic interventions were suggested for Continental Maritime: 1) upright scaling, chipping, and needle gun tools for the deck scraping process or 2) wheeled, adjustable work stools and knee supports for the deck scraping process, and other processes involving prolonged kneeling or squatting tasks 3) portable workbenches for the duct installation process 4) worker awareness training for welders/ grinders working overhead or in confined spaces (such as those in the in onboard deck fitting and pipe welding processes).Of these interventions, it is expected that the upright scaling, chipping, and needle gun tools and portable workbenches can have significant impact on reducing musculoskeletal injuries.

It is suggested that further action can be taken to mitigate the exposure to musculoskeletal risk factors with each of the identified tasks. The implementation of engineered ergonomic interventions has been found to reduce the amount and severity of musculoskeletal disorders within the working population in various industries.

Each of the interventions proposed in this document are to be considered preliminary concepts. Full engineering analyses by the participating shipyard are expected prior to the implementation of any particular suggested intervention concept to determine feasibility, both financial and engineering, as well as to identify potential safety considerations.

VI. REFERENCES

Hudock, S. D., and S. J. Wurzelbacher. 2001a. Preliminary Survey Report: Pre-Intervention Quantitative Risk Factor Analysis for Ship Repair Processes at Continental Maritime of San Diego, Inc. Shipyard, San Diego, California. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Cincinnati, Ohio, Report # EPHB 229-16a, August 2001, 104 pp. Available at www.cdc.gov/niosh/ergship/reports.html.

Hudock, S. D., and S. J. Wurzelbacher. 2001b. Interim Survey Report: Recommendations for Ergonomics Interventions for Ship Repair Processes at Continental Maritime of San Diego, Inc. Shipyard, San Diego, California. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Cincinnati, Ohio, Report # EPHB 229-16b, August 2001, 23 pp. Available at www.cdc.gov/niosh/ergship/reports.html.